Poll results and Commentary
from the
Third PMT workshop:
Getting Control of PMT and vPvM substances
under REACH

Hans Peter H. Arp

25’th – 26’th March, 2021
Poll results and commentary

Contact: hpa@ngi.no
Poll #1: What are the most important gaps for PMT substances? (Please pick 3)

Timepoint: Start of workshop

**Substance Assessment**
- Availability of Persistency data?
- Availability of Mobility data?
- Availability for Toxicity data?
- Availability of Analytical methods?
- Availability of Monitoring data?
- Availability of transformation products and mixture composition?

**Risk Governance**
- Missing risk assessment tools/models?
- Missing water remediation infrastructure?
- Missing chemical legislation?
- Missing safe and sustainable substitutes?
Results of Poll #1*

1. Availability of transformation products and mixture composition? (48%)
2. Availability of analytical methods? (44%)
3. Availability of monitoring data? (37%)
4. Missing safe and sustainable substitutes? (29%)
5. Missing risk assessment tools/models? (28%)
6. Missing chemical legislation? (26%)
7. Availability for toxicity data? (24%)
8. Availability of mobility data? (21%)
9. Availability of persistency data? (19%)
10. Missing water remediation infrastructure? (15%)

* Data corrected for number of unique respondents, ignores «no response» and double responses
n=336 workshop participants responded
(ca 166 attendants with no response)

Reemtsma et al. ES&T 2016
Commentary on poll # 1 (beginning of workshop)

- There was a wide spread in opinion, with 15% to 48% of each individual gap being selected as one of the top three gaps.
- “Availability of transformation products and mixture composition” was the biggest gap, with 48% of respondents putting this in their top three.
- This was followed by “Availability of analytical methods” (number 2) and “Availability of monitoring data” (number 3) data gaps. In some ways these are linked to each other, as you cannot monitor if no analytical methods are there, and you often analytical methods are not developed until there is a monitoring indication. Further the transformation product/mixture gap is also related, as transformation and mixtures can make a large amount of «unknowns» in monitoring campaigns, and also represent an «unknown» chemicals to look for, as often structures are missing.
- Information about P, M and T properties was ranked low (gaps 7-9)
- Risk governances gaps were in the middle (ranked 4-6) including the availability of appropriate risk assessment models, safe and sustainable substitutes, and chemical legislation. What is interesting in this regard as these gaps in risk governance require information on P, M and T substance properties, as well as information on all other gaps.
- “Missing water treatment infrastructure” was ranked as the smallest gap, could this mean at the audience felt that water treatment infrastructure is sufficient?
- As will be presented in the results of the next poll at the end of the workshop, there was a huge shift in the opinion of gaps, in part due the workshop giving a better understanding of the state-of-the art and providing a clearer definition of the gaps.
For the same gaps as the first poll, we presented the first glimpse at new project results and a summary of the workshop in relation to each “gap”

Then at the end of the presentation, the audience was given 20 minutes if they think each gap is huge, closing or small

Hans Peter made a prediction of audience response before the polls were open. This was not necessarily Hans Peter’s personal opinion, but how he anticipated the audience would respond by the end of the workshop.

The slides below compare Hans Peter’s prediction of audience poll with the audience polling, and also of the first poll

Approx. n = 120 audience members responded to poll #2; Approx. n = 240 did not respond, depending on question
**Gap 1: Availability of Persistency data? Prediction**

- **HPA’s prediction**
  - Little/no information for low volume/intermediate REACH substances
  - Mandatory PBT assessment for substances > 10 tpa contributes to more testing: Effect of PBT/vPvB regulation
  - Screening tests for ready/inherent biodegradability useful for demonstrating «Not P»
Gap 1: Availability of **Persistency** data? Results

**HPA’s prediction**
- 40%: Little/no information for low volume/intermediate REACH substances
- 40%: Mandatory PBT assessment for substances > 10 tpa contributes to more testing: Effect of PBT/vPvB regulation
- 20%: Screening tests for ready/inherent biodegradability useful for demonstrating «Not P»

**Audience**
- 41%: 
- 50%: 
- 9%

HPA commentary: Very close match!
Gap 2: Availability of Mobility data? Prediction

HPA’s prediction

- $K_{oc}$ data for ionic substances rare and scattered, $D_{ow}$ does not account for ion-exchange

- Neutral substances – lots of data and good models. Many ionic substances have $K_{oc}$ values orders of magnitude from threshold

![Graph showing REACH registered organic substances meeting the P, vP or Potential P/vP++ criteria](image)

- Minimum log $K_{oc}$, log $K_{ow}$ or log $D_{ow}$ (pH 4-9)

- "analytical gap"
Gap 2: Availability of Mobility data? Results

HPA’s prediction

- $K_{oc}$ data for ionic substances rare and scattered, $D_{ow}$ does not account for ion-exchange
- Neutral substances – lots of data and good models. Many ionic substances have $K_{oc}$ values orders of magnitude from threshold

Audience

- 37%
- 47%
- 16%

HPA commentary:

Count as a miss: I thought the audience would be more convinced that the mobility data available is a minor/closing gap. I agree for a fraction of ionic substances this is a huge gap, but for the majority of substances I am not concerned.
Gap 3: Availability of Toxicity data? Prediction

HPA’s prediction

- Lack of data on PM/vPvM chemicals, despite chronic exposure. Few long-term physiologically based pharmokinetic (PBPK) models.
- Attention on PFAS is inspiring increasing research on effects from chronic water exposure.
- Lots of required testing due to CLP.

![Graph showing Toxicity Conc. for PM/vPvM substances registered under REACH](chart)

- Not T (no Cramer III indication) - 51
- Potential T (Cramer III indication) - 586
- T-dw. Priority 1b (ED + other criteria) - 103
- T Priority 1a Annex XIII - 169
**Gap 3: Availability of Toxicity data? Results**

**HPA’s prediction**

- Lack of data on PM/vPvM chemicals, despite chronic exposure. Few long-term physiologically based pharmokinetic (PBPK) models.
- Attention on PFAS is inspiring increasing research on effects from chronic water exposure.
- Lots of required testing due to CLP.

**Audience**

- 60%
- 30%
- 10%

**HPA commentary:**
Partial hit/miss

I thought a larger fraction of the audience would think there is enough toxicity testing and conclude «minor gap». I personally agree this is a major gap, but was surprised the audience did too.
Gap 4: Availability of Analytical methods? Prediction

HPA’s prediction

- Target analysis still needed for extremely mobile substances (e.g. log D < -2/3); standards HARD to come by

- VAST improvements in the past 5 years in relation to target and non-target analysis (e.g. HILIC columns, Super critical fluid chromatography, suspect screening databases such as the Norman Network SLE)

Figure adapted from Reemtsma et al. ES&T 2016
Gap 4: Availability of Analytical methods? results

<table>
<thead>
<tr>
<th>HPA’s prediction</th>
<th>Audience</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>30% Target analysis still needed for extremely mobile substances (e.g. log D &lt; -2/3); standards HARD to come by</td>
<td>33%</td>
</tr>
<tr>
<td>40% VAST improvements in the past 5 years in relation to target and non-target analysis (e.g. HILIC columns, Super critical fluid chromatography, suspect screening databases such as the Norman Network SLE)</td>
<td>57%</td>
</tr>
<tr>
<td>30%</td>
<td>11%</td>
</tr>
</tbody>
</table>

HPA commentary:
Very close prediction!
Though I thought a somewhat larger portion of the audience would say there was «no analytical gap» as we have so many great methods out there.
An **incentive** gap: why monitor unless requested/share data unless requested. Only seeing tip of the «chemical iceberg» via research community. Big data and cheminformatics are needed for international data repositories.

State-of-the-art research labs paving the way!

Number of water analysis labs in Germany that routinely analyze for them.
Gap 5: Availability of Monitoring Data? Results

HPA’s prediction

- 70%: An incentive gap: why monitor unless requested/share data unless requested. Only seeing tip of the «chemical iceberg» via research community

- 20%: State-of-the-art research labs paving the way!

Audience

- 64%
- 32%
- 4%

HPA commentary: A very close prediction!
Gap 6: Transformation products and mixture composition? Prediction

HPA’s prediction

- For all REACH:
  - ONLY 451 transformation products identified through experimental databases (EAWAG BBD, Norman SLE)
  - QSARs give multiple predictions (see Zheng et al.)
  - Ca 30% of organic substances in REACH are complex mixtures (UVCBs)

- Melamine transforming to even more vPvM chemicals (Zheng et al. ES&T 2020, 10.1021/acs.est.0c02593)

- 6PPD (REACH vPvM & PMT) -> killer of Coho Salmon (Tian et al. Science 2020 https://science.sciencemag.org/content/371/6525/185)
Gap 6: Transformation products and mixture composition? (Results)

For all REACH:

- ONLY 451 transformation products identified through experimental databases (EAWAG BBD, Norman SLE)
- QSARs give multiple predictions (see Zheng et al.)
- Ca 30% of organic substances in REACH are complex mixtures (UVCBs)

HPA’s prediction:

- 80%
- 10%
- 10%

Audience:

- 91%
- 7%
- 2%

HPA commentary:

Another very close prediction, and maybe the least surprising one.
Gap 7: Missing risk assessment tools/models? Prediction

HPA’s prediction

- Mobility gap – ionic substances have complex behaviour
- Toxicity gap – unknown long term exposure effects
- Diffuse emissions, bank filtrate/ground water are inherently complex and not covered by generic models

- Well established agriculture plant protection product (PPP) and waste water treatment plant (WWTP models for specific scenarios (EUSES, SimpleTreat)
Gap 7: Missing risk assessment tools/models? Results

HPA’s prediction

- Mobility gap – ionic substances have complex behaviour
- Toxicity gap – unknown long term exposure effects
- Diffuse emissions, bank filtrate/ground water are inherently complex and not covered by generic models

- Well established agriculture plant protection product (PPP) and waste water treatment plant (WWTP models for specific scenarios (EUSES, SimpleTreat)

Audience

- 34%
- 53%
- 10%

HPA commentary:

I will call this a miss prediction, as clearly more of the audience though risk assessment tools were adapting to PMT/vPvM substances than I did. Personally I still think the gap is quite large, as it represents the sum of many gaps (e.g. emissions, M, T)
Gap 8: Missing water remediation infrastructure? (rank 10)

HPA’s prediction

A gap that cannot be fully closed. Many “pristine”, or developing countries have limited drinking water production infrastructure – rely on chemical regulation to ensure protection.

Regrettable remediation: Most PMT/vPvM only removable with RO / super expensive, resource intensive treatment: Economic, Efficiency and Sustainability concerns.

Advance treatment methods work best at emission source

Screening of 158 PMT/vPvM substances Arp and Hale 2019. Suitable water treatments:

<table>
<thead>
<tr>
<th>Technique</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neither O₃ nor AC</td>
<td>52,5</td>
</tr>
<tr>
<td>Only O₃</td>
<td>15,8</td>
</tr>
<tr>
<td>Only AC</td>
<td>20,9</td>
</tr>
<tr>
<td>Both</td>
<td>10,8</td>
</tr>
</tbody>
</table>

K.Nödler, preliminary results

Tortajada and van Rensburg, Nature, 2019
Gap 8: Missing water remediation infrastructure? Prediction

HPA’s prediction

70%
A gap that cannot be fully closed. Many “pristine”, or developing countries have limited drinking water production infrastructure – rely on chemical regulation to ensure protection.

20%
Regrettable remediation: Most PMT/vPvM only removable with RO / super expensive, resource intensive treatment: Economic, Efficiency and Sustainability concerns.

10%
Advance treatment methods work best at emission source

Audience

56%

20%

13%

HPA commentary:
I will call this a good prediction, especially considering in the first poll the audience did not see water remediation as a major gap, but I think day 1 (especially) convinced them that it was.
Gap 9: Missing chemical legislation? Prediction

HPA’s prediction

30%

- Harmonization to be explored across risk and hazard based legislation and regulation (CLP, REACH, PPPR, WHO GV, DWD, E-PRTR)

50%

- The Chemicals Strategy for Sustainability and Zero Pollution Ambition
  - Inclusion of PMT/vPvM in for REACH / CLP
  - PFAS restriction
  - Safe and Sustainable by Design

20%

- Existing tools
  - Article 57f
  - PPPR

Jin et al. https://pubs.acs.org/doi/10.1021/acs.est.0c04281
Gap 9: Missing chemical legislation? Results

HPA’s prediction

- 30%
  - Harmonization to be explored across risk and hazard based legislation and regulation (CLP, REACH, PPPR, WHO GV, DWD, E-PRTR)

- 50%
  - The Chemicals Strategy for Sustainability and Zero Pollution Ambition
    - Inclusion of PMT/vPvM in for REACH / CLP
    - PFAS restriction
    - Safe and Sustainable by Design

- 20%
  - Existing tools
    - Article 57f
    - PPPR

Audience

- 63%
- 23%
- 14%

HPA commentary:
A fairly good prediction. The audience is generally convinced that the CSS and EU Green Deal will do a lot to close the gaps!
Gap 10: Missing safe and sustainable substitutes (rank 4)

HPA’s prediction

- Technical / economic challenges
- Definition of «essential use»
- Safe and sustainable by design / green chemistry techniques concept and techniques rapidly developing
- Sustainable material and process engineering
- Majority of high production chemicals are NOT PMT/νPvM
- Strong societal/industry support
- Humans are innovators

[Bar charts showing data]
Gap 10: Missing safe and sustainable substitutes (Prediction)

HPA’s prediction:
- Technical / economic challenges
- Definition of «essential use»
- Safe and sustainable by design / green chemistry techniques concept and techniques rapidly developing
- Sustainable material and process engineering
- Majority of high production chemicals are NOT PMT/vPvM
- Strong societal/industry support
- Humans are innovators

Audience:
- 60%
- 34%
- 10%

HPA commentary:
A poor prediction, but not a total miss. What I got wrong is assuming more of the audience would think there are easy to find substitutes out there, but what I got right is that this the audience thinks this is a serious gap.
Comparing Poll #1 and Poll #2: Changes in opinions about the biggest gaps over the workshop?

### Substance Assessment

- Availability of Persistency data?
- Availability of Mobility data?
- Availability for Toxicity data?
- Availability of Analytical methods?
- Availability of Monitoring data?
- Availability of transformation products and mixture composition?

### Risk Governance

- Missing risk assessment tools/models?
- Missing water remediation infrastructure?
- Missing chemical legislation?
- Missing safe and sustainable substitutes?

<table>
<thead>
<tr>
<th></th>
<th>Poll #1</th>
<th>Poll #2</th>
</tr>
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<tbody>
<tr>
<td><strong>When</strong></td>
<td>Start of workshop</td>
<td>End of workshop</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>1 hour</td>
<td>20 min</td>
</tr>
<tr>
<td><strong>Structure</strong></td>
<td>Top three gaps</td>
<td>Status of each gap: huge, closing, minor</td>
</tr>
<tr>
<td><strong>Ranking</strong></td>
<td>Frequency selected in top three</td>
<td>Frequency «huge gap» was selected</td>
</tr>
<tr>
<td><strong>N value</strong></td>
<td>Ca 366 of 502 participants</td>
<td>Ca 120 of 340 participants</td>
</tr>
<tr>
<td><strong>Notes</strong></td>
<td>- Definition of «gaps» more clearly defined before Poll #2</td>
<td>- Did not control for same participants in both polls.</td>
</tr>
</tbody>
</table>
### Comparison of poll ranking of «biggest gaps»

<table>
<thead>
<tr>
<th>Issue</th>
<th>Begin of workshop</th>
<th>End of workshop</th>
<th>HPA’s End predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of trans. prod. and mixture comp</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Availability of analytical methods</td>
<td>2</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Availability of monitoring data</td>
<td>3</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Missing safe and sustainable substitutes</td>
<td>4</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Missing risk assessment tools/models</td>
<td>5</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Missing chemical legislation</td>
<td>6</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Availability for toxicity data</td>
<td>7</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>Availability of mobility data</td>
<td>8</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Availability of persistency data</td>
<td>9</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Missing water remediation infrastructure</td>
<td>10</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>
We have the tools, let us close the gaps to get control!

- PMT/νPvM In CLP & REACH
- Harmonization of PMT/νPvM definitions within risk assessment models and regulations
- Big data monitoring data and suspect list harmonization (e.g. non-target in E-PRTR)
- Remediation at emission sources rather than downstream
- Safe and sustainable chemistry

Non-toxic heirarchy of the Chemical Strategy for Sustainability

- Safe and Sustainable Chemicals
- Minimize and Control
- Eliminate and remediate

Status quo

Zero pollution of PM substances